4. Holmes, E.: Intranasal treatment of Meckel's ganglion, Ann. Otol., Rhinol. and Laryngol., June, 1913.

5. Pollock, H.: Difficulties and complications of sphenopalatine ganglion injections, Ann. Otol., Rhinol. and Laryngol., 1906, xxv, 958–966.

6. Cushing, H.: Perineal zoster; with notes upon cutaneous segmentation postaxial to the lower limb, Am. Jour. Med. Sc., March, 1904.

7. Hunt, J. R.: Herpetic inflammations of the geniculate ganglion, Tr. Am. Neurol. Assn., 1906.

8. Hunt, J. R.: A further contribution to the herpetic inflammations of the geniculate ganglion, Am. Jour. Med. Sc., August, 1908.

9. Hunt, J R..: The sensory system of the facial nerve and its symptomatology, Jour. Nerv. and Ment. Dis., 1909, xxxvi, 331–350.

10. Hunt, J. R.: The sensory field of the facial nerve: a further contribution to the symptomatology of the geniculate ganglion, Brain, 1915, xxxviii, 418.

11. Hunt, J. R.: Otalgia considered as an affection of the seventh cranial nerve, Arch. Otol., 1907, vol. xxxvi.

12. Clark and Taylor: Tic douloureux of the sensory filaments of the geniculate ganglion; operation; recovery, Jour. Nerv. and Ment. Dis., 1910, xxxvii, 242, 511.

13. Clark and Taylor: True tic douloureux of the sensory filaments of the facial nerve, Jour. Am. Med. Assn., 1909, liii, 2144.

14. Cushing, H.: The sensory distribution of the fifth cranial nerve, Johns Hopkins Hosp. Bull., 1904, xv, 213–232.

15. Hellsten, M.: Ein Fall von Ganglion Gasseri-Tumor, Deutsche Ztschr. f. Nervenheilk., 1914, lii, 290–305.

16. Krause, F.: Operationen in der hinteren Schädelgrube, Arch. f. klin. Chir., 1906, lxxxi, 40–60.

17. Lexer, E.: Zur Operation des Ganglion Gasseri nach Erfahrungen an 15 Fällen, Arch. f. klin. Chir., 1902, lxv, 843–928.

18. Weisenburg, T.: Cerebellopontile tumor diagnosed for six years as tic douloureux, Jour. Am. Med. Assn., 1910, liv, 1600–1604.

19. Dercum, F. X., Keen, W. W., and Spiller, W. G.: Endothelioma of the Gasserian ganglion; two successive resections of the ganglion; first by the extradural (Hartley-Krause) operation, and, secondly, by an intradural operation, Jour. Am. Med. Assn., 1900, xxxiv, 1026–1033.

20. Frazier, C.: An operable tumor involving the Gasserian ganglion, Am. Jour. Med. Sc., 1918, clvi, 483–490.

21. Homen, E.: Zur Kenntniss der Hemiatrophia facialis und des Ursprungs des Nervus trigeminus, Neurol. Centralbl., 1890, ix, 385, 430.

NUMBER OF RADIOGRAMS AND ROENTGEN-RAY BURNS.

By W. D. Witherbee, M.D.,

NEW YORK.

(From the Rockefeller Institute for Medical Research, New York.)

The maximum number of exposures in a given case that can be made without producing a roentgen-ray burn, an erythema or a temporary or permanent alopecia can be obtained by the formula used for determining unfiltered dosage. The principle of this formula is based upon the fact that roentgen-ray burns, alopecia, etc., depend entirely on the quantity of a roentgen ray reaching the skin, as pointed out by Remer and Witherbee in June, 1917.[1]

---

[1] Am. Jour. Roentgenol., June, 1917; also a more recent article published in Arch. Dermatol. and Syphilol., May, 1920.

The standard formula for 1 skin unit, or the amount used for treatment of ringworm of the scalp, is expressed as follows:

$$\frac{3 \text{ sp. gr.} \times 3 \text{ ma.} \times 4 \text{ min.}}{8\text{-inch distance} \times 8\text{-inch distance}} = \frac{9}{16} = 1 \text{ skin unit.}$$

To illustrate the practical application of the above fraction $\frac{9}{16}$, let us take the factors given in the *Army Manual* for the various exposures, then estimate the skin distance from the target of the tube in each position of a patient whose measurements are a little above the average, substituting the skin distance in each case for the plate distance. This formula, with the skin distance substituted for the plate distance for an A. P. Head, would be:

$$\frac{5 \text{ sp. gr.} \times 40 \text{ ma.} \times \frac{1}{5} \text{ of a minute}}{12\text{-inch distance} \times 12\text{-inch distance}}$$

instead of 20-inch plate distance. This reduced to a simple fraction equals:

$$\frac{5 \times \overset{\overset{5}{\cancel{10}}}{\cancel{40}} \times \frac{1}{\cancel{5}}}{\underset{3}{\cancel{12}} \times \underset{6}{\cancel{12}}} = \frac{5}{18}$$

If the fraction $\frac{5}{18}$ or its formula represents the dose for each exposure, then the number of plates taken to produce a temporary alopecia, or 1 skin unit, would be the number of times $\frac{5}{18}$ is contained in $\frac{9}{16}$:

$$\frac{9}{16} \div \frac{5}{18} = \frac{9}{\underset{8}{\cancel{16}}} \times \frac{\overset{9}{\cancel{18}}}{5} = \frac{81}{40} = 2\frac{1}{40} \text{ plates.}$$

Therefore:

	Sp. gr.	Ma.	Time minutes.	Plate distance inches.	Skin distance inches.	Number of plates.
Head, A. P.	5	40	$\frac{1}{5}$	20	12	2
Head Lat.	5	40	$\frac{1}{10}$	20	14	5
Neck	5	40	$\frac{1}{20}$	20	16	14
Shoulder	5	40	$\frac{1}{120}$	20	10	5
Elbow	5	40	$\frac{1}{40}$	20	17	34
Wrist	5	40	$\frac{1}{60}$	20	18	54
Kidney	5	40	$\frac{1}{15}$	20	10	4
Bladder	5	40	$\frac{1}{15}$	20	12	6
Hip-joint	5	40	$\frac{1}{12}$	20	12	5
Pelvis	5	40	$\frac{1}{12}$	20	12	5
Knee	5	40	$\frac{1}{30}$	20	15	19
Ankle	5	40	$\frac{1}{40}$	20	17	34
Lumbar spine	5	40	$\frac{1}{10}$	20	10	4
Teeth (slow film)	5	40	$\frac{1}{15}$	20	18	13
Teeth (fast film)	5	40	$\frac{1}{40}$	20	18	36
Chest	5	40	$\frac{1}{15}$	28	16	11

The importance of the distance of the skin from the target of the tube is well illustrated in the list of number of plates, especially in the case of kidney and bladder exposures; here the only change in the four factors is in the distance. The difference in distance is 2 inches, which makes a difference of two in the number of plates. This should make one exceedingly cautious when dealing with excessively large individuals whose thickness demands the maximum exposure.

For one who is not using the army factors and who has inadvertently used the wrong factors in a given case to obtain the best results, and wishes to repeat the procedure, it is a simple matter to determine the dosage the skin has already received and then decide whether it would be safe to repeat or postpone the operation for a time.

In taking a series of plates or films, overlapping of the areas exposed must be considered even though the factors are correct and properly maintained throughout each exposure.

From the foregoing list of number of plates it is obvious that the head, kidney, bladder, pelvis and lumbar spine are the ones that require the larger doses to obtain results. If a case of this kind is passed on from one roentgen-ray laboratory to another, in a comparatively short time, and standard exposures made in each place, a roentgen-ray burn may occur. Roentgenologists, and especially those who specialize in the branches in which these large doses are required to obtain good plates, would appreciate a complete roentgen-ray history as well as clinical history of these cases. By a complete roentgen-ray history is meant the time the plates were taken, the position of the patient, the factors used in making the exposures and the date of the last examination. With these data the roentgenologist could determine at once how soon it would be safe to proceed with his examination, instead of waiting three or four weeks from the date of the last exposure in order to avoid either increasing an already produced burn or adding enough more to produce one that otherwise would be a safe and sane exposure.

Erythema appears in from ten to fourteen days, so that at the end of three weeks one is safe in concluding, if the skin appears normal, that the exposure the patient has had was not sufficient to produce an erythema. But the dose may have been of such intensity that by adding the large amount necessary for the second examination may induce an alopecia or erythema by the combined exposures. If an erythema or temporary alopecia has occurred during the third week after the first examination it would seem advisable to wait at least six weeks from the date of the last exposure.

From a medicolegal standpoint it would seem assured that the defendant would be in a much better position to defend himself if he knew his factors and the valuation of the same in determining the cause of roentgen-ray burns.

The army factors with an interrupterless machine and a Coolidge radiator type tube whose maximum working factors are 5-inch gap and 30 ma., would mean a change from 40 ma. to 30 ma. and a proportionate increase in the time of the exposure. For example, the factors given for an A. P. Head are 5-inch gap, 40 ma. at 20-inch distance, with 12 seconds time. To compensate for the one-quarter decrease in milliameter, the time given in army formula (12 seconds), would equal three-quarters; one-fourth would be 4 seconds and four-fourths 16 seconds, or the time necessary to produce the same effect on the plate.

The principle involved in the adaptation of the above-mentioned radiator tube to the army formula may be illustrated by Prof. J. S. Shearer's roentgenographic formula:

$$\frac{40\text{ ma.}\times(5\text{ K V})^2\times\frac{1}{5}\text{ minute}}{(20\text{-inch distance})^2}=\frac{\overset{\overset{2}{\cancel{10}}}{\cancel{40}}\times\cancel{5}\times\cancel{5}\times\frac{1}{\cancel{5}}}{\underset{\cancel{4}}{\cancel{20}}\times\underset{\cancel{4}_2}{\cancel{20}}}=\frac{1}{2}$$

$$\frac{30\text{ ma}\times(5\text{ K V})^2\times\text{time}}{(20\text{-inch distance})^2}=\frac{\overset{15}{\cancel{30}}\times\cancel{5}\times\cancel{5}\times T}{\underset{\cancel{4}_2}{\cancel{20}}\times\underset{4}{\cancel{20}}}=\frac{15}{8}$$

$$\frac{1}{2}\div\frac{15}{8}=\frac{1}{\cancel{2}}\times\frac{\overset{\cancel{4}}{\cancel{8}}}{15}=\frac{4}{15}\text{ minutes}=16\text{ seconds.}$$

By interposing $\frac{1}{2}$ mm. aluminum filter, three times the number of plates may be made, and with 1 mm. aluminum filter six times the number of plates without danger to the patient. This is based on the time necessary to produce $1\frac{1}{2}$ skin units of filtered roentgen ray, using $\frac{1}{2}$ and 1 mm. aluminum filter with the army factors and skin distance instead of plate distance. From the regular formula 12 seconds is the time for one plate of an A. P. Head. With a skin distance of 12 inches $2\frac{1}{10}$ plates can be taken without a filter. The time necessary to produce $1\frac{1}{2}$ filtered skin units, which corresponds to $\frac{3}{4}$ unit unfiltered biologically, using $\frac{1}{2}$ mm. al. = about 1 minute, 12 seconds with 1 mm. al. = about 2 minutes. Therefore, 1 minute and 12 seconds = 72 seconds ÷ 12 seconds = 6 plates, or three times the number allowed without $\frac{1}{2}$ mm. al. filter. 2 minutes = 120 seconds ÷ 12 seconds = 10 plates, or 5 times the number indicated without 1 mm. al. filter.